

## REMARKS

The above amendments to the above-captioned application along with the following remarks are being submitted as a full and complete response to the Office Action dated December 15, 2004. In view of the above amendments and the following remarks, the Examiner is respectfully requested to give due reconsideration to this application, to indicate the allowability of the claims, and to pass this case to issue.

### Status of the Claims

Claims 1 and 3-6 are under consideration in this application. Claim 2 is being cancelled without prejudice or disclaimer. Claims 1 and 5 are being amended, as set forth in the above marked-up presentation of the claim amendments, in order to more particularly define and distinctly claim applicants' invention.

### Additional Amendments

The claims are being amended to correct formal errors and/or to better disclose or describe the features of the present invention as claimed. All the amendments to the claims are supported by the specification. Applicants hereby submit that no new matter is being introduced into the application through the submission of this response.

### Prior Art Rejections

Claims 1-5 were rejected under 35 U.S.C. §102(e) as being anticipated by U.S. Pat. No. 6,337,513 to Clevenger et al. (hereinafter "Clevenger"), and claim 6 was rejected under 35 U.S.C. §103(a) as being unpatentable over Clevenger in view of U.S. Pat. No. 4,914,551 to Anschel (hereinafter "Anschel"). The references of Clevenger et al (6,579,743), Eldridge (6,627,980), Tobita (6,652,958), Hiatt (6,673,649), Chrysler (6,770,966), Pinneo (2002/0141155), Ishikawa (2004/0191558), Tobita et al. (2001/0004546), Ye (6,724,631), Patel (5,396,403), and Sullivan (5,391,914) were cited as being pertinent to the present application. These rejections have been carefully considered, but are most respectfully traversed.

The semiconductor device 1 having a heat spreader 2 of the invention, as now recited in claim 1, comprises a diamond-containing material having a thermal conductivity  $t$ , where  $350 \leq t < 1000 \text{ W/(m}\cdot\text{K)}$ . The heat spreader 2 is directly disposed entirely or partially on the reverse surface of the semiconductor device 1. The diamond-containing material is (1) a composite of a diamond layer and a ceramic layer or (2) a mixture of diamond particles and

ceramic particles, wherein the ceramic layer or the ceramic particles comprises at least one of silicon carbide and aluminum nitride.

The invention, as now recited in claim 5, is also directed to a semiconductor package accommodating the semiconductor device having a heat spreader recited in claim 1, a metal heat sink or a metal radiating fin bonded on a surface of the heat spreader facing away from the semiconductor device.

Although diamond has a thermal conductivity of up to 2200 W/(m·K), just using diamond will significantly increase manufacturing costs. Therefore, the invention combines diamond with ceramics such as SiC and AlN (p. 10, lines 9-13) to provide a heat spreader with a sufficient high thermal conductivity  $t$ , where  $350 \leq t < 1000$  W/(m·K). The  $t$  of the combination/mixture therefore ranges above AlN's thermal conductivity of 200 W/(m·K) and SiC's thermal conductivity of 270 W/(m·K) (p. 10, lines 19-21), and below 1000 W/(m·K) (Table 1 of Clevenger).

Applicants contend that none of the cited prior art references teaches or suggests such a “(1) composite of a diamond layer and a ceramic layer or (2) mixture of diamond particles and ceramic particles, the ceramic layer or the ceramic particles comprising at least one of silicon carbide and aluminum nitride providing having a thermal conductivity  $t$ ,  $350 \leq t < 1000$  W/(m·K)” as does the invention.

Contrary to the Examiner's assertion (p. 5, 2<sup>nd</sup> paragraph of the outstanding Office Action), Clevenger merely forms each of the diamond thin film layers of diamond **or** diamond-like materials, for example diamond-like carbon or silicon carbide (col. 3, lines 11, “*Each of the foregoing structures are preferably fabricated of diamond or diamond-like materials, for example diamond-like carbon or silicon carbide (hereinafter collectively referred to as "diamond").*” 18-20). In other words, Clevenger's diamond thin film layer is made of either diamond with a thermal conductivity between 1000-2000 W/(m·K), or diamond-like carbon (DLC), or SiC with a thermal conductivity of 270 W/(m·K), rather than a combination/mixture of diamond, SiC/AlN with a thermal conductivity  $t$ ,  $350 \leq t < 1000$  W/(m·K).

Anschel fails to compensate for Clevenger's deficiencies. Anschel's heat spreader 37 was selected from silicon carbide, aluminum nitride **or** copper-clad Invar materials (col. 3, lines 48-50), but not any combination/mixture thereof. In addition, Anschel's election of materials was based upon coefficients of thermal expansion (col. 3, lines 53), rather than a thermal conductivity of the combination/mixture as does the invention.

Although the invention applies diamond, SiC, AlN as disclosed in Clevenger or

Anschel, the invention applies a combination/mixture of diamond, SiC, AlN to achieve unexpected results or properties, such as to reduce manufacturing costs while providing a thermal conductivity  $t$ , where  $350 \leq t < 1000$  W/(m·K). The presence of these unexpected properties is evidence of nonobviousness. MPEP § 716.02(a).

*"Presence of a property not possessed by the prior art is evidence of nonobviousness. In re Papesch, 315 F.2d 381, 137 USPQ 43 (CCPA 1963) (rejection of claims to compound structurally similar to the prior art compound was reversed because claimed compound unexpectedly possessed anti-inflammatory properties not possessed by the prior art compound); Ex parte Thumm, 132 USPQ 66 (Bd. App. 1961) (Appellant showed that the claimed range of ethylene diamine was effective for the purpose of producing "'regenerated cellulose consisting substantially entirely of skin'" whereas the prior art warned "this compound has 'practically no effect.'").*

Applicants will point out that "[t]he submission of evidence that a new product possesses unexpected properties does not necessarily require a conclusion that the claimed invention is nonobvious. In re Payne, 606 F.2d 303, 203 USPQ 245 (CCPA 1979). See the discussion of latent properties and additional advantages in MPEP § 2145." However, the three unexpected properties were unknown and non-inherent functions in view of Clevenger and/or Anschel, since they will not inherently achieve the same results. In other words, these advantages would not flow naturally from following the prior art teachings since they fail to suggest applying a combination/mixture of diamond, SiC, AlN to provide a heat spreader with a thermal conductivity  $t$ , where  $350 \leq t < 1000$  W/(m·K).

Applicants further contend that the mere fact that one of skill in the art could rearrange Clevenger and Anschel, to meet the terms of the claims is not by itself sufficient to support a finding of obviousness. The prior art must provide a motivation or reason for one skilled in the art to provide the unexpected properties, such as to reduce manufacturing costs while providing a thermal conductivity  $t$ , where  $350 \leq t < 1000$  W/(m·K), without the benefit of appellant's specification as a guide to make the necessary changes in the reference device. *Ex parte Chicago Rawhide Mfg. Co.*, 223 USPQ 351, 353 (Bd. Pat. App. & Inter. 1984). MPEP § 2144.04 VI C.

Applicants contend that neither Clevenger, Anschel, nor their combination teaches or suggests each and every feature of the present invention as recited in at least independent claims 1 and 5. As such, the present invention as now claimed is distinguishable and thereby allowable over the rejections raised in the Office Action. The withdrawal of the outstanding

prior art rejections is in order, and is respectfully solicited.

Conclusion

In view of all the above, clear and distinct differences as discussed exist between the present invention as now claimed and the prior art reference upon which the rejections in the Office Action rely, Applicants respectfully contend that the prior art references cannot anticipate the present invention or render the present invention obvious. Rather, the present invention as a whole is distinguishable, and thereby allowable over the prior art.

Favorable reconsideration of this application is respectfully solicited. Should there be any outstanding issues requiring discussion that would further the prosecution and allowance of the above-captioned application, the Examiner is invited to contact the Applicants' undersigned representative at the address and phone number indicated below.

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